

**PREVALENCE OF OSTEOPENIA AND
OSTEOPOROSIS: THE ASSESSMENT OF
OSTEOPOROSIS KNOWLEDGE, HEALTH BELIEF
AND SELF-EFFICACY AMONG PATIENTS WITH
TYPE 2 DIABETES MELLITUS IN PENANG**

SHAYMAA ABD ALWAHED ABDUL AMEER

UNIVERSITI SAINS MALAYSIA

2014

**PREVALENCE OF OSTEOPENIA AND OSTEOPOROSIS:
THE ASSESSMENT OF OSTEOPOROSIS KNOWLEDGE,
HEALTH BELIEF AND SELF-EFFICACY AMONG
PATIENTS WITH TYPE 2 DIABETES MELLITUS IN
PENANG**

By

SHAYMAA ABD ALWAHED ABDUL AMEER

**Thesis submitted in fulfilment of the requirements for the
degree of Doctor of Philosophy**

February 2014

ACKNOWLEDGEMENTS

First and foremost, all praises and gratefulness goes to the Almighty for the strengths and blessing in completing this thesis. I would like to express my heartfelt gratitude to my main supervisor, **Professor Dr. Syed Azhar Syed Sulaiman**, my co-supervisors, **Associate Professor Dr. Mohamed Azmi Ahmad Hassali**, and my field supervisor **Dr. Karupiah Subramaniam**, for all their efforts in providing a conducive environment for me to do this research. Their creative guidance, constructive criticism, intellectual support, valuable advices and encouragement throughout the study are gratefully acknowledged.

A very grateful and special thanks to whole staff of School of Pharmaceutical Sciences, Universiti Sains Malaysia, and Diabetes Outpatient Clinic, Hospital Pulau Pinang for their co-operation, and valuable contributions to my field work. Big thanks to **Institute of Postgraduate Studies (IPS)**, Universiti Sains Malaysia, for awarding me USM Postgraduate Student Fellowship during the whole period of my study.

A great thank from my heart to my beloved **mother, father, brothers** and **sister** for their endless love, prayer, encouragement and support. Special appreciation and my heartfelt thanks to my husband, **Dr. Mohanad Naji Sahib**, for his sincere encouragement and inspiration throughout my research work and lifting me uphill in this phase of life, and to my beloved children **Hiba** and **Ahmed** for their understanding and patience throughout the period of study, I owe everything to them.

Shaymaa Abd Alwahed Abdul Ameer

2014

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	ii
TABLE OF CONTENTS.....	iii
LIST OF TABLES	xvii
LIST OF FIGURES	xxiii
LIST OF APPENDICES	xxv
LIST OF ABBREVIATIONS & SYMBOLS.....	xxvi
LIST OF PUBLICATIONS & COMMUNICATIONS	xxx
ABSTRAK	xxxvii
ABSTRACT	xl
CHAPTER ONE: INTRODUCTION	1
1.1 Background of the study.....	1
1.1.1 Osteoporosis.....	1
1.1.2 Diabetes mellitus.....	4
1.2 Osteoporosis and diabetes mellitus in Malaysia.....	7
1.2.1 Osteoporosis in Malaysia.....	7
1.2.2 Diabetes mellitus in Malaysia.....	9
1.3 Osteoporosis care and prevention.....	10
1.4 Osteoporosis knowledge, health belief and self-efficacy	12
1.4.1 Osteoporosis knowledge	12
1.4.2 Osteoporosis health beliefs	14
1.4.3 Osteoporosis self-efficacy.....	15
1.5 Research Problems	16
1.6 Rationale of the study	17

1.7 Significance of the study	20
1.8 Research objectives and questions	22
1.8.1 Objective of the study	22
1.8.2 Research questions.....	24
1.9 Thesis overview.....	24
CHAPTER TWO: LITERATURE REVIEW	26
2.1 Osteoporosis	26
2.1.1 Definition of osteoporosis.....	26
2.1.2 Types of osteoporosis and risk factors.....	27
2.1.3 Diagnosis of osteoporosis	29
2.1.4 Clinical presentation of osteoporosis	30
2.1.5 Osteoporosis complication.....	31
2.1.6 Osteoporosis management	31
2.1.6.1 Osteoporosis education	32
2.1.6.2 Role of dietary calcium intake	32
2.1.6.3 Role of exercise.....	33
2.1.6.4 Pharmacological treatment of osteoporosis	34
2.2 Diabetes mellitus	37
2.2.1 Definition of diabetes mellitus.....	37
2.2.2 Types of diabetes	37
2.2.3 Diagnosis of diabetes	39
2.2.4 Clinical presentations of type 2 diabetes mellitus (T2DM).....	40
2.2.5 Diabetes complications	40
2.2.5.1 Acute complications of diabetes	41
2.2.5.2 Chronic complications of diabetes	41

2.2.6 Diabetes management	43
2.2.6.1 Diabetes education	43
2.2.6.2 Diet.....	44
2.2.6.3 Exercise	44
2.2.6.4 Pharmacological treatment of type 2 diabetes	45
2.3 Osteoporosis in type 2 diabetes mellitus	48
2.4 Health behaviour theory	60
2.4.1 Health belief model.....	60
2.4.2 Social cognitive theory	61
2.4.3 Osteoporosis knowledge, health belief, and self-efficacy	62
2.5 Conceptual frame work of the study	67
CHAPTER THREE: PSYCHOMETRIC PROPERTIES OF OSTEOPOROSIS	
KNOWLEDGE, HEALTH BELIEF AND SELF-EFFICACY SCALES	
AMONG MALAYSIAN TYPE 2 DIABETES PATIENTS	70
3.1 Introduction	70
3.2 Methodology	73
3.2.1 Study design and setting	73
3.2.2 Participants.....	74
3.2.3 Sample size	74
3.2.4 Instruments.....	75
3.2.5 Instrument translation	77
3.2.6 Procedure	79
3.2.7 Statistical analysis.....	79
3.2.7.1 Validity.....	80
3.2.7.1.1 Face validation	80

3.2.7.1.2 Content validation	82
3.2.7.1.3 Construct validity	83
3.2.7.2 Reliability	85
3.2.7.3 Item analysis for osteoporosis knowledge test Malay version (OKT-M)	86
3.2.7.3.1 Item Difficulty Index	86
3.2.7.3.2 Item discrimination Index	87
3.2.7.3.3 Point biserial correlation	87
3.2.7.3.4 Discriminatory power	88
3.2.7.4 Quantitative Ultrasound (QUS) Measurements	88
3.2.7.5 Receiver operating characteristic (ROC) curve analysis	89
3.2.8 Ethics approval	90
3.3 Results	91
3.3.1 Socio-demographic and diabetes characteristics data	91
3.3.2 Validation study of OKT-M, OHBS-M and OSES-M	94
3.3.2.1 Face validation	94
3.3.2.1.1 Face validation for osteoporosis knowledge test Malay version (OKT-M)	94
3.3.2.1.2 Face validation for osteoporosis health belief scale Malay version (OHBS-M)	96
3.3.2.1.3 Face validation for osteoporosis self-efficacy scale Malay version (OSES-M)	98
3.3.2.2 Content validation	99
3.3.2.2.1 Content validation for osteoporosis knowledge test Malay version (OKT-M)	99

3.3.2.2.2 Content validation for osteoporosis health belief scale Malay version (OHBS-M)	101
3.3.2.2.3 Content validation for osteoporosis self-efficacy Malay version (OSES-M).....	104
3.3.2.3 Construct validity	105
3.3.2.3.1 Construct validity for OHBS-M	105
3.3.2.3.1.1 Exploratory factor analysis (EFA) for OHBS-M.....	105
3.3.2.3.1.2 Confirmatory factor analysis (CFA) for OHBS-M.....	108
3.3.2.3.2 Construct validity for OSES-M.....	113
3.3.2.3.2.1 Exploratory factor analysis (EFA) for OSES-M.....	113
3.3.2.3.2.2 Confirmatory factor analysis (CFA) for OSES-M.....	115
3.3.3 Internal Consistency	118
3.3.3.1 Internal Consistency of OKT-M	118
3.3.3.2 Internal Consistency of OHBS-M.....	120
3.3.3.3 Internal Consistency of OSES-M.....	122
3.3.4 Item analysis for OKT-M	124
3.3.5 Quantitative ultrasound measurements (QUS)	126
3.3.6 Receiver operating characteristic (ROC) curve Analysis	126
3.3.6.1 Receiver operating characteristic (ROC) curve Analysis for OKT-M	126
3.3.6.2 Receiver operating characteristic (ROC) curve Analysis for OHBS-M	128
3.3.6.3 Receiver operating characteristic (ROC) curve Analysis for OSES-M	130
3.4 Discussion	132

3.5 Conclusions	138
CHAPTER FOUR: THE PREVALENCE OF OSTEOPENIA AND OSTEOPOROSIS AMONG TYPE 2 DIABETIC PATIENTS USING QUANTITATIVE ULTRASOUND (QUS) DENSITOMETER.....	139
4.1 Introduction	139
4.2 Methodology	143
4.2.1 Research design	143
4.2.2 Study setting	143
4.2.3 Population and sampling method.....	144
4.2.4 Sample size	146
4.2.5 Bone mass measurements	147
4.2.6 Socio-demographic characteristics and health status.....	150
4.2.7 Diabetes-related variables.....	151
4.2.8 Ethical considerations	152
4.2.9 Statistical analysis.....	153
4.3 Results	154
4.3.1 Overall response rate	154
4.3.2 Prevalence of osteoporotic status and health bone status	154
4.3.2.1 Prevalence of osteoporotic condition regarding gender groups.....	155
4.3.2.2 Prevalence of osteoporotic conditions regarding age groups.....	156
4.3.2.3 Prevalence of osteoporotic condition with menopausal status.....	158
4.3.2.4 Prevalence of osteoporotic conditions according to ethnicity	159
4.3.3 The QUS parameters of the calcaneus stratified by age decade and gender	160

4.3.4 Correlation between T-score and patients' demographic characteristics, diabetes-related variables, lipid profile and blood pressure findings	163
4.3.5 Correlation between QUS parameters and patients' demographic characteristics, diabetes-related variables, lipid profile and blood pressure findings	165
4.3.6 Association between QUS-score (normal BMD, osteopenia and osteoporosis) and patients' demographic characteristics, diabetes-related data, and lipid and blood pressure profiles	167
4.3.6.1 Association between QUS-score and demographic data among type 2 diabetes patients	167
4.3.6.2 Association between QUS-score and diabetes-related variables among type 2 diabetic patients	171
4.3.6.3 Association between QUS-score and lipid and blood pressure profiles among diabetes type 2 patients	172
4.4 Discussion	174
4.4.1 Prevalence of osteoporotic status in diabetic patients	175
4.4.2 Calcaneal QUS parameters stratified by age groups and gender	178
4.4.3 The correlation between QUS parameter and T-score value with patients' demographic characteristics, diabetes-related variables, lipid profile and blood pressure	179
4.4.4 Osteoporotic status and patients' demographic characteristics	184
4.4.4.1 Osteoporotic status and patients' anthropometric measurements	184
4.4.4.2 Osteoporotic status and gender	187
4.4.4.2.1 Men	188
4.4.4.2.2 Women and Menopausal Status	191

4.4.4.2.2.1 Postmenopausal women.....	191
4.4.4.2.2.2 Premenopausal status.....	194
4.4.4.3 Osteoporotic status and ethnicity	196
4.4.4.4 Osteoporotic status and education.....	197
4.4.4.5 Osteoporotic status and living place	198
4.4.4.6 Osteoporotic status and alcohol consumption.....	199
4.4.4.7 Osteoporotic status and smoking	200
4.4.4.8 Osteoporotic status and family history of osteoporosis and fracture	201
4.4.5 Osteoporotic status and lipid profile	203
4.4.6 Osteoporotic status and blood pressure profile.....	204
4.4.7 Osteoporotic status and diabetes-related variables	206
4.4.7.1 Glycaemic control	206
4.4.7.2 Diabetes mellitus duration.....	208
4.5 Conclusion.....	210
CHAPTER FIVE: ASSESSMENT OF OSTEOPOROSIS KNOWLEDGE, HEALTH BELIEF AND SELF-EFFICACY AMONG ADULTS WITH TYPE 2 DIABETES MELLITUS IN THE STATE OF PENANG	213
5.1 Introduction	213
5.2 Methodology	217
5.2.1 Research design	217
5.2.2 Study setting	218
5.2.3 Population and sampling method.....	218
5.2.4 Sample size	221
5.2.5 Research instruments	221
5.2.5.1 Questionnaire Design.....	222

5.2.5.2 Socio-demographic characteristics.....	222
5.2.5.3 Diabetes-related data and laboratory finding results.....	223
5.2.5.3.1 Diabetes-related data	223
5.2.5.3.2 Other Laboratory Test Results	224
5.2.5.4 Osteoporosis Knowledge test Malay version (OKT-M).....	225
5.2.5.5 Osteoporosis Health Belief Scale Malay version (OHBS-M).....	226
5.2.5.6 Osteoporosis Self-Efficacy Scale Malay version (OSES-M).....	226
5.2.5.7 Quantitative Ultrasound (QUS) Measurements	227
5.2.6 Ethical considerations	228
5.2.7 Data collection procedures.....	228
5.2.8 Research hypotheses	229
5.2.9 Statistical data analysis	229
5.3 Results	231
5.3.1 Demographic and diabetes-related data description	231
5.3.1.1 Overall response rate.....	231
5.3.1.2 Demographic characteristics	232
5.3.1.3 Diabetes-related variables	234
(a) Basic diabetes data	234
(b) Diabetes complications and co-morbid diseases	235
(c) Lipid profile and blood pressure finding of the study population.....	236
(d) Medications used by the study patients	237
5.3.2 Osteoporosis knowledge assessment	239
5.3.2.1 Frequency of correct and incorrect answers to the osteoporosis knowledge test Malay version (OKT-M).....	240
5.3.2.2 The knowledge of risk factors of osteoporosis	243

5.3.2.3 The knowledge of exercise toward osteoporosis (OKT-M Exercise subscale).....	244
5.3.2.4 The knowledge of calcium toward osteoporosis (OKT-M Calcium subscale).....	245
5.3.2.5 Source of patient knowledge about osteoporosis	245
5.3.2.6 Relationship between osteoporosis knowledge (OKT-M) levels and demographic characteristic groups.....	246
5.3.2.7 Differences in the OKT-M scores between groups of demographic characteristics	249
5.3.2.8 Relationship between osteoporosis knowledge levels and diabetes-related variables	252
5.3.2.9 Differences in OKT-M scores between groups of diabetes-related variables	253
5.3.2.10 Correlations between the OKT-M total scores and lipid profile and blood pressure findings	255
5.3.2.11 Differences in OKT-M total scores with lipid profile and blood pressure findings	255
5.3.3 Osteoporosis health belief assessment.....	257
5.3.3.1 Relationship between osteoporosis health belief (OHBS-M) levels and demographic characteristics groups	264
5.3.3.2 Differences in the OHBS-M scores among groups of demographic characteristics.....	267
5.3.3.3 Relationship between osteoporosis health belief levels and diabetes-related variables	270

5.3.3.4 Differences in OHBS-M scores between groups of diabetes-related variables	272
5.3.3.5 Correlations between OHBS total score and lipid profile and blood pressure findings	273
5.3.3.6 Differences in OHBS-M score between groups of lipid profile and blood pressure	274
5.3.4 Osteoporosis self-efficacy assessment.....	275
5.3.4.1 Relationship between osteoporosis self-efficacy (OSES-M) levels and demographic characteristics groups	278
5.3.4.2 Differences in the OSES-M scores among groups of demographic characteristics	282
5.3.4.3 Relationship between osteoporosis self-efficacy levels and diabetes-related variables	284
5.3.4.4 Differences in OSES-M scores between groups of diabetes-related variables	287
5.3.4.5 Correlations between OSES-M total score and lipid profile and blood pressure findings	289
5.3.4.6 Differences in OSES-M score between groups of lipid profile and blood pressure	290
5.3.5 Correlation	291
5.3.5.1 Correlations between osteoporosis knowledge, health belief and self-efficacy total scores.....	292
5.3.5.2 Relationships between OKT-M, OHBS-M and OSES-M scores in calcium and exercise subscales	292

5.3.5.3 Correlations between T-scores and osteoporosis knowledge (OKT-M), health belief (OHBS-M) and self-efficacy (OSES-M) total scores and subscale scores.....	294
5.3.6 Multinomial logistic regression to assess factors that predict osteopenia and osteoporosis among type 2 diabetic patients.....	295
5.4 Discussion	304
5.4.1 Demographic characteristics and diabetes-related variables description	304
5.4.1.1 Demographic characteristics	304
5.4.1.2 Basic diabetes-related data.....	306
5.4.1.3 Complications, co-morbidity and laboratory values	307
5.4.1.4 Medications used.....	309
5.4.2 Osteoporosis knowledge assessment	310
5.4.2.1 Knowledge of risk factors of osteoporosis.....	312
5.4.2.2 Knowledge of exercise toward osteoporosis.....	317
5.4.2.3 Knowledge of calcium toward osteoporosis	319
5.4.2.4 Sources of osteoporosis Knowledge	324
5.4.2.5 Osteoporosis knowledge and demographic characteristics.....	327
5.4.2.5.1 Osteoporosis knowledge and age	327
5.4.2.5.2 Osteoporosis knowledge and Gender	328
5.4.2.5.3 Osteoporosis knowledge and education level.....	330
5.4.2.5.4 Osteoporosis knowledge and income	331
5.4.2.5.5 Osteoporosis knowledge and employment status.....	332
5.4.2.5.6 Osteoporosis knowledge and living place	333
5.4.2.5.7 Osteoporosis knowledge and family history of fracture and/or osteoporosis	334

5.4.2.5.8 Osteoporosis knowledge and alcohol or smoking habits	336
5.4.2.6 Osteoporosis knowledge and diabetes-related variables.....	336
5.4.2.7 Osteoporosis knowledge, lipid profile and blood pressure findings .	337
5.4.3 Osteoporosis health belief assessment.....	337
5.4.3.1 Perceived susceptibility of osteoporosis	338
5.4.3.2 Perceived seriousness of osteoporosis	339
5.4.3.3 Perceived benefit of exercise	340
5.4.3.4 Perceived benefit of dietary calcium intake	341
5.4.3.5 Perceived barrier to exercise	342
5.4.3.6 Perceived barrier to dietary calcium intake.....	342
5.4.3.7 Health motivation.....	345
5.4.3.8 Osteoporosis health beliefs and demographic characteristics.....	346
5.4.3.8.1 Osteoporosis health beliefs and age	346
5.4.3.8.2 Osteoporosis health belief and gender.....	347
5.4.3.8.3 Osteoporosis health belief and family history of fractures and/or osteoporosis	348
5.4.3.8.4 Osteoporosis health belief and other demographic characteristics data	350
5.4.3.9 Osteoporosis health belief and diabetes-related data	351
5.4.3.10 Osteoporosis health belief, lipid profile and blood pressure findings	351
5.4.4 Osteoporosis self-efficacy assessment.....	351
5.4.4.1 Osteoporosis self-efficacy and demographic characteristics	354
5.4.4.2 Osteoporosis self-efficacy and diabetes-related variables	357

5.4.4.3 Osteoporosis self-efficacy and lipid profile and blood pressure findings	357
5.4.5 Correlation	358
5.4.5.1 Correlations of the osteoporosis knowledge, health belief and self-efficacy scale and subscale scores.....	358
5.4.5.1.1 Exercise Subscales correlations.....	359
5.4.5.1.2 Calcium Subscales Correlations	361
5.4.5.2 Correlations between T-scores and the osteoporosis knowledge (OKT-M), health belief (OHBS-M) and self-efficacy (OSES-M) scores.....	363
5.4.6 Multinomial logistic regression (MLR) analysis to predict factors associated with QUS measurement scores.....	364
5.5 Conclusions	370
CHAPTER SIX: CONCLUSIONS AND RECOMMENDATIONS	376
6.1 Conclusions of the study findings	376
6.1.1 Introduction.....	376
6.1.2 Conclusions of the validation part	377
6.1.3 Conclusions of the bone mineral density measurements part using quantitative ultrasound (QUS) densitometer	378
6.1.4 Conclusions of osteoporosis knowledge, health belief, self-efficacy and QUS measurements part	379
6.2 Recommendations	382
6.3 Study limitations.....	384
REFERENCES.....	386
APPENDICES	

LIST OF TABLES

Table 2.1 Defining osteoporosis by bone mineral density (BMD)	27
Table 2.2 Secondary causes of osteoporosis	28
Table 2.3 Risk factors for osteoporosis	29
Table 2.4 Medications used for the treatment of osteoporosis.....	35
Table 2.5 Medications used for the treatment of hyperglycaemia in type 2 diabetes mellitus.....	46
Table 2.6 Studies conducted to assess the relationship between osteoporosis and type 2 diabetes mellitus.....	54
Table 2.7 Studies conducted to assess osteoporosis knowledge, health belief, and self-efficacy.....	63
 Table 3.1 Demographic characteristics of T2DM patients; data expressed as M±SD or frequency (percentage, %)	 92
Table 3.2 Face validity (Task B) results for the osteoporosis knowledge test Malay version (OKT-M)	95
Table 3.3 Face validity (Task B) results for the osteoporosis health belief scale Malay version (OHBS-M).....	97
Table 3.4 Face validity (Task B) results for the osteoporosis self-efficacy scale Malay version (OSSES-M)	99
Table 3.5 Content validity ratio (CVR) results for the osteoporosis knowledge test Malay version (OKT-M).....	100
Table 3.6 Content validity ratio (CVR) Results for the osteoporosis health belief scale Malay version (OHBS-M)	102

Table 3.7 Content validity ratio (CVR) Results for the osteoporosis self-efficacy scale Malay version (OSES-M)	104
Table 3.8 Component matrix of exploratory factor analysis for osteoporosis health belief scale Malay version (OHBS-M)	106
Table 3.9 Convergent validity of the osteoporosis health belief scale Malay version (OHBS-M)	110
Table 3.10 Discriminant validity of the osteoporosis health belief scale Malay version (OHBS-M).....	112
Table 3.11 Component matrix of exploratory factor analysis for osteoporosis self-efficacy scale Malay version (OSES-M).....	114
Table 3.12 Convergent validity of osteoporosis self-efficacy scale Malay version (OSES-M)	117
Table 3.13 Discriminant validity of the osteoporosis self-efficacy scale Malay version (OSES-M).....	117
Table 3.14 Reliability test of the osteoporosis knowledge test Malay version (OKT-M).....	119
Table 3.15 Reliability test of the osteoporosis health belief scale Malay version (OHBS-M)	121
Table 3.16 Reliability test of the osteoporosis self-efficacy scale Malay version (OSES-M)	123
Table 3.17 Psychometric Properties of the osteoporosis knowledge test Malay version (OKT-M) by item analysis	125
Table 3.18 Sensitivity, Specificity, Positive and Negative Predictive Values for the osteoporosis knowledge test Malay version (OKT-M).....	128

Table 3.19 Sensitivity, Specificity, Positive and Negative Predictive Values for the osteoporosis health belief scale Malay version (OHBS-M).....	130
Table 3.20 Sensitivity, Specificity, Positive and Negative Predictive Values for the osteoporosis self-efficacy scale Malay version (OSES-M)	132
Table 4.1 The QUS parameters of the calcaneus stratified by age groups and gender (N=450).....	162
Table 4.2 Correlations of the T-score with patients' demographic characteristics, diabetes-related variables, lipid profile and blood pressure findings (N=450).....	164
Table 4.3 Correlation between QUS parameter value and clinical data (N=450)...	166
Table 4.4 The main patient characteristics regarding the prevalence of osteoporosis and osteopenia among type 2 diabetic patients (N=450)	169
Table 4.5 Relationships between QUS score and diabetes-related variables (N=450)	172
Table 4.6 Relationships between QUS score and groups of lipid and blood pressure profiles findings (N=450).....	173
Table 5.1 Socio-demographic characteristics of the study patients (N=450).....	233
Table 5.2 Diabetes-related data of the study population (N=450)	235
Table 5.3 Distribution of the diabetes complications and co-morbidities among the studied patients (N=450)	236
Table 5.4 Frequency and percent of lipid profile and blood pressure groups among the studied population (N=450)	237
Table 5.5 Distribution of medications used among the studied population	238

Table 5.6 Description of osteoporosis knowledge test Malay version (OKT-M) total constructs and the two subscales (N=450)	239
Table 5.7 Distribution of the two osteoporosis knowledge levels (N=450).....	240
Table 5.8 Percentage of correct and incorrect answer of study patients for the OKT-M (N=450)	241
Table 5.9 Sources of patient knowledge about osteoporosis.....	246
Table 5.10 Relationships between osteoporosis knowledge levels and patients' demographic characteristics (N=450)	248
Table 5.11 The OKT-M scores differences between demographic groups of the study population (N=450).....	250
Table 5.12 Relationships between osteoporosis knowledge levels and diabetes-related variables (N=450).....	253
Table 5.13 Difference in OKT-M total scores among diabetes-related characteristics groups (N=450)	254
Table 5.14 Correlations of lipid profile and blood pressure findings with the OKT-M total score (N=450)	255
Table 5.15 Differences in OKT-M total score with lipid profile and blood pressure findings (N=450).....	256
Table 5.16 Distribution of the two osteoporosis health belief levels (N=450)	257
Table 5.17 Description of osteoporosis health belief scale (OHBS-M) total constructs and the seven subscales (N=450).....	259
Table 5.18 Osteoporosis health belief scale Malay version (OHBS-M): The response by subscale category (N=450).....	260
Table 5.19 Relationships between osteoporosis health belief levels and patients' demographic characteristics (N=450)	266

Table 5.20 The OHBS-M scores differences among groups of demographic characteristics (N=450)	268
Table 5.21 Relationships between osteoporosis health belief levels and diabetes-related variables (N=450).....	271
Table 5.22 Difference in OHBS-M scores among diabetes-related characteristics groups (N=450)	273
Table 5.23 Correlations of lipid profile and blood pressure findings with the OHBS-M total score (N=450).....	274
Table 5.24 Differences in OHBS-M score between groups of lipid profile and blood pressure findings (N=450)	275
Table 5.25 Description of osteoporosis self-efficacy scale (OSES-M) total constructs and the two subscales (N=450)	276
Table 5.26 Distribution of the two osteoporosis self-efficacy scale levels (N=450)	277
Table 5.27 Description of osteoporosis self-efficacy scale (OSES-M) total constructs (N=450).....	278
Table 5.28 Relationships between osteoporosis self-efficacy levels and patients' demographic characteristics (N=450)	280
Table 5.29 The OSES-M scores differences among groups of demographic characteristics (N=450)	283
Table 5.30 Relationships between OSES-M levels and diabetes-related variables (N=450)	286
Table 5.31 Difference in OSES-M scores among diabetes-related characteristics groups (N=450)	288

Table 5.32 Correlations of lipid profile and blood pressure findings with the OSES-M total score (N=450).....	289
Table 5.33 Differences in OSES-M score between groups of lipid profile and blood pressure findings (N=450)	291
Table 5.34 Correlation between OKT-M, OSES-M and OHBS-M scores in the calcium and exercise subscales	293
Table 5.35 Correlation between T-scores and osteoporosis knowledge, health belief and self-efficacy scores (N=450)	295
Table 5.36 Dependent and independent variable names and definitions used in the analysis (case processing summary)	296
Table 5.37 Model Fitting Information.....	297
Table 5.38 Goodness-of-Fit.....	298
Table 5.39 Results of multinomial logistic regression analysis to determine predictors for osteopenia and/or osteoporosis among T2DM patients.....	303

LIST OF FIGURES

Figure 2.1 Possible deleterious effects of diabetes mellitus on bone metabolism and bone quality.....	53
Figure 2.2 Conceptual framework.....	69
Figure 3.1 The scree plot of the osteoporosis health belief scale Malay version (OHBS-M).	108
Figure 3.2 The scree plot of the osteoporosis self-efficacy scale Malay version (OSES -M).	115
Figure 3.3 Receiver operating characteristic (ROC) curve for the osteoporosis knowledge test Malay version (OKT-M).	127
Figure 3.4 Receiver operating characteristic (ROC) curve for the osteoporosis health belief scale Malay version (OHBS-M).	129
Figure 3.5 Receiver operating characteristic (ROC) curve for the osteoporosis self-efficacy scale Malay version (OSES-M).....	131
Figure 4.1 Prevalence of osteoporotic status in type 2 diabetic patients.....	155
Figure 4.2 Prevalence of osteoporotic conditions according to gender in type 2 diabetic patients.....	156
Figure 4.3 Prevalence of osteoporotic conditions within the age group <65 years in type 2 diabetic patients.....	157
Figure 4.4 Prevalence of osteoporotic conditions within the age group ≥ 65 years in type 2 diabetic patients.....	158

Figure 4.5 Prevalence of osteoporotic conditions according to menopausal status in type 2 diabetic patients..... 159

Figure 4.6 Prevalence of osteoporotic condition according to ethnicity in type 2 diabetic patients..... 160

LIST OF APPENDICES

- Appendix 1** Ethical approval of the study (MREC and NIH approvals)
- Appendix 2** Exploratory statement and consent form for participants for validation and assessment parts (English and Malay versions)
- Appendix 3** Independent Face and Content Validation Form
- Appendix 4** Data collection form for validation part (English and Malay versions)
- Appendix 5** Questionnaire for validation and assessment part (English and Malay versions)
- Appendix 6** Data collection form for assessment part (English and Malay versions)
- Appendix 7** Data collection form from medical record (English and Malay versions)
- Appendix 8** Translation of questionnaires certificate
- Appendix 9** Calculation of face validation
- Appendix 10** Pre-viva presentation certificate

LIST OF ABBREVIATIONS & SYMBOLS

AVE	Average Variances Extracted
AGFI	Adjusted Goodness-Of-Fit Index
AMOS	Analysis of Moment Structures
AGE	Advanced Glycation End Products
ACE	Angiotensin Converting Enzyme Inhibitor
ANOVA	One Way Analysis Of Variance
ANCOVA	Analysis Of Covariance
AUC	Area Under the Curve
BMD	Bone Mineral Density
BMI	Body Mass Index
BP	Blood Pressure
BUA	Broadband Ultrasound Attenuation
CR	Composite Reliability
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CRC	Clinical Research Centre
CVR	Content Validity Ratio
CVI	Content Validity Index
CVD	Cardiovascular Disease
cm	Centimetre
CI	Confidence Interval
DXA	Dual-Energy X-Ray Absorptiometry
DM	Diabetes Mellitus

DBP	Diastolic Blood Pressure
dB/MHz	decibels/megahertz
eBMD	Estimate Bone Mineral Density
EFA	Exploratory Factor Analysis
FBS	Fasting Blood Sugar
g/cm ²	Grams per Square Centimetre
GFI	Goodness Of Fit Index
HDLC	High-Density Lipoprotein Cholesterol
HbA1c	Glycosylated Haemoglobin
HBM	Health Belief Model
HPP	Hospital Pulau Pinang
HC	Hip Circumference
IDF	International Diabetes Federation
IHD	Ischaemic Heart Disease
IGF	Insulin-Like Growth Factor
kHz	Kilohertz
kg/m ²	kilogram per square metre
KMO	Kaiser-Meyer-Olkin
LDLC	Low-Density Lipoprotein Cholesterol
LBMD	Low Bone Mineral Density
LR	Likelihood Ratio
MREC	Medical Research and Ethics Committee
mmol/L	millimoles per Liter
mg/dL	milligrams/deciliter
MHz	Megahertz

M±SD	mean±standard deviations
m/s	meters/second
MLR	Multivariate Multinomial Logistic Regression
NHMS III	The Third National Health And Morbidity Survey
NOF	National Osteoporosis Foundation
NPV	Negative Predictive Value
OR	Odds Ratio
OKT	Osteoporosis Knowledge Test
OHBS	Osteoporosis Health Belief Scale
OSes	Osteoporosis Self-Efficacy Scale
OKT-M	Osteoporosis Knowledge test Malay version
OHBS-M	Osteoporosis Health Belief Scale Malay version
OSes-M	Osteoporosis Self-Efficacy Scale Malay version
PASW	Predictive Analytics Software
PBM	Peak Bone Mass
PVD	Peripheral Vascular Disease
PNFI	Parsimonious Normed Fit Index
PGFI	Parsimony Goodness Of Fit Index
PPV	Positive Predictive Value
%	Percent
QUS	Quantitative Ultrasound Scan
RDI	Recommended Daily Intake
ROC	Receiver Operating Characteristic
RMSEA	Root Mean Square Error Of Approximation
RM	Ringgit Malaysia

SI	Stiffness Index
SOS	Speed of Sound
SD	Standard Deviations
SBP	Systolic Blood Pressure
SCT	Social Cognitive Theory
SME	Subject-Matter-Experts
SEM	Structural Equation Modelling
TLI	Tucker-Lewis Index
TC	Total Cholesterol
TG	Triglyceride
T1DM	Type 1 Diabetes Mellitus
T2DM	Type 2 Diabetes Mellitus
T.V	Television
UKPDS	United Kingdom Prospective Diabetes Study
USM	Universiti Sains Malaysia
U.S.	United State
UK	United Kingdom
UAE	Urinary Albumin Excretion
WHO	World Health Organisation
WC	Waist Circumference
WHR	Waist to Hip Ratio

LIST OF PUBLICATIONS & COMMUNICATIONS

Publications

International Journals

1. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2013). Psychometric properties and osteoprotective behaviors among type 2 diabetic patients: osteoporosis self-efficacy scale Malay version (OSES-M). *Osteoporosis International*. **24** (3), 929-940. **(Impact Factor: 4.58)**.
2. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2013). Psychometric properties of osteoporosis knowledge tool and self-management behaviours among Malaysian type 2 diabetic patients. *Journal of Community Health*. **38** (1), 95-105. **(Impact Factor: 1.293)**.
3. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Osteoporosis and type 2 diabetes mellitus: what do we know, and what we can do? *Patient Preference and Adherence*. **6**:435-448. **(Impact Factor: 1.333)**.
4. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2014). Psychometric Properties of the Malay version of Osteoporosis Health Belief Scale (OHBS-M) Among Type 2 Diabetic Patients. *International Journal of Rheumatic Disease*. **17**:93-105. **(Impact Factor: 1.65)**.

5. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Is there a link between osteoporosis and type 1 diabetes? Findings from a systematic review of the literature. *Diabetology International*. **3** (3), 113-130. **(Scopus index journal)**.
6. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Translation and validation of osteoporosis health belief scale into Malaysian version among type 2 diabetics patients. *Value in Health*. **15** (7):A476-A476. **(Impact Factor: 3.032)**.
7. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Translation and validation of osteoporosis knowledge tool into Malaysian version among type 2 diabetics patients. *Value in Health*. **15** (7):A478-A478. **(Impact Factor: 3.032)**.
8. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Assessment of the osteoporosis self-efficacy scale in relation to osteoprotective behaviours among type 2 diabetics patients in north Malaysia. *Value in Health*. **15** (7):A451-A451. **(Impact Factor: 3.032)**.
9. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Translation and validation of osteoporosis self-efficacy scale into Malaysian version among type 2 diabetics patients. *Value in Health*. **15** (7):A478-A478. **(Impact Factor: 3.032)**.

- 10. Abdulameer S.A.,** Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Predictors of osteoporosis knowledge among type 2 diabetic patients in north Malaysia: A pilot study. *Osteoporosis International*. **23**:S779-S780. **(Impact Factor: 4.58).**
- 11. Abdulameer S.A.,** Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). The incidence and knowledge toward osteoporosis among type 2 diabetic patients: a pilot study in north Malaysia. *Osteoporosis International*. **23**:S780-S781. **(Impact Factor: 4.58).**
- 12. Abdulameer S.A.,** Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Diagnostic performance of the Malay version osteoporosis knowledge tool for identifying osteoporosis among type 2 Malaysian diabetic patients. *Osteoporosis International*. **23**:S781-S781. **(Impact Factor: 4.58).**
- 13. Abdulameer S.A.,** Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2012). Receiver operating characteristic curve analysis for evaluating the diagnostic accuracy of Malay version osteoporosis health belief scales among type 2 diabetic patients. *Osteoporosis International*. **23**:S781-S781. **(Impact Factor: 4.58).**

National Journals

- 1. Abdulameer S.A.,** Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. (2011). Is there a link between osteoporosis and diabetes?

findings from a systematic review of the literature. *Malaysian Journal of Pharmacy*. 1(9):S424.

Conferences

International Conferences

1. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Translation and validation of osteoporosis health belief scale into Malaysian version among type 2 diabetics patients. The International Society of Pharmacoeconomics and Outcomes Research (ISPOR) 15th Annual European Congress, (November 3-7, 2012, ICC Berlin, **Germany**). Poster presentation.
2. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Translation and validation of osteoporosis knowledge tool into Malaysian version among type 2 diabetics patients. The International Society of Pharmacoeconomics and Outcomes Research (ISPOR) 15th Annual European Congress, (November 3-7, 2012, ICC Berlin, **Germany**). Poster presentation.
3. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Assessment of the osteoporosis self-efficacy scale in relation to osteoprotective behaviours among type 2 diabetics patients in north Malaysia. The International Society of Pharmacoeconomics and Outcomes Research (ISPOR) 15th Annual European Congress, (November 3-7, 2012, ICC Berlin, **Germany**). Poster presentation.

4. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Translation and validation of osteoporosis self-efficacy scale into Malaysian version among type 2 diabetics patients. The International Society of Pharmacoeconomics and Outcomes Research (ISPOR) 15th Annual European Congress, (November 3-7, 2012, ICC Berlin, **Germany**). Poster presentation.

National Conferences

1. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Predictors of osteoporosis knowledge among type 2 diabetic patients in north Malaysia: A pilot study. The International Osteoporosis Foundation (IOF) Regionals-3rd Asia-Pacific Osteoporosis Meeting, (December 13-16, 2012 - Kuala Lumpur, **Malaysia**). Poster presentation.
2. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. The incidence and knowledge toward osteoporosis among type 2 diabetic patients: a pilot study in north Malaysia. The International Osteoporosis Foundation (IOF) Regionals-3rd Asia-Pacific Osteoporosis Meeting, (December 13-16, 2012 - Kuala Lumpur, **Malaysia**). Poster presentation.
3. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Diagnostic performance of the Malay version osteoporosis knowledge tool for identifying osteoporosis among type 2 Malaysian diabetic patients. The International Osteoporosis Foundation (IOF) Regionals-3rd

Asia-Pacific Osteoporosis Meeting, (December 13-16, 2012 - Kuala Lumpur, **Malaysia**). Poster presentation.

4. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Receiver operating characteristic curve analysis for evaluating the diagnostic accuracy of Malay version osteoporosis health belief scales among type 2 diabetic patients. The International Osteoporosis Foundation (IOF) Regionals-3rd Asia-Pacific Osteoporosis Meeting, (December 13-16, 2012 - Kuala Lumpur, **Malaysia**). Poster presentation.
5. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Diagnostic performance of the Malay version osteoporosis self-efficacy scale for identifying osteoporosis in type 2 diabetic patients. International Conference on Multidisciplinary Research (iCMR), (November 1-3, 2012, Universiti Sains Malaysia (USM), Pulau Pinang, **Malaysia**). Oral presentation.
6. **Abdulameer S.A.**, Syed Sulaiman S.A., Hassali M.A., Subramaniam K., Sahib M.N. Is there a link between osteoporosis and diabetes? findings from a systematic review of the literature. Malaysian Pharmaceutical Society-Pharmacy Scientific Conference (MPS-PSC) 2011: Advancing Competencies for Future Practice (October 21-23, 2011 Istana Hotel, Kuala Lumpur, **Malaysia**). Poster presentation.

Awards

- 1. USM Postgraduate Student Fellowship Award.**

A fellowship for 3 years (2011-2013), awarded from Institute of Postgraduate Studies (IPS), Universiti Sains Malaysia (USM).

- 2. Research University Postgraduate Research Grant Scheme (RU-PRGS).**

A research university grant (1001/PFARMASI) for 3 years (2013-2015), awarded from the Universiti Sains Malaysia (USM).

**PREVALENS DARIPADA OSTEOPENIA DAN OSTEOPOROSIS:
PENILAIAN TENTANG PENGETAHUAN, KEPERCAYAAN KESIHATAN
DAN KECEKAPAN DIRI TERHADAP OSTEOPOROSIS DALAM
KALANGAN PESAKIT DIABETES MELLITUS JENIS 2 DI PULAU
PINANG**

ABSTRAK

Kedua-dua diabetes mellitus jenis 2 (T2DM) dan osteoporosis adalah suatu keadaan yang kronik dan perkaitan di antara kedua-duanya juga amat kompleks. Pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis adalah asas kepada semua program pengurusan osteoporosis dan ia juga merupakan prasyarat bagi memulakan perubahan tingkah laku. Justeru, matlamat kajian ini adalah untuk menilai prevalens keadaan osteoporotik dan tahap pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis dalam kalangan pesakit T2DM di Pulau Pinang.

Instrumen yang digunakan untuk menilai tahap pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis adalah ujian pengetahuan osteoporosis (OKT), skala kepercayaan kesihatan osteoporosis (OHBS) dan skala kecekapan diri osteoporosis (OSES), masing-masing. Sampel seramai 250 orang pesakit dipilih daripada klinik pesakit luar diabetes di Hospital Pulau Pinang (HPP) bagi mengesahkan ketiga-tiga skala tersebut (OKT-M, OHBS-M dan OSES-M) dalam konteks versi di Malaysia. Suatu prosedur standard '*forward-backward*' digunakan

untuk menterjemah skala ke dalam bahasa Melayu. Kebolehpercayaannya diuji bagi kekonsistenan dalam dan kesahihan disahkan dengan menggunakan muka, kandungan dan kesahihan binaan. Keputusan menunjukkan bahawa kebolehpercayaan dan kesahihan adalah boleh diterima. Di samping itu, analisis keluk ROC (ciri operasi penerima) digunakan untuk menentukan nilai-potongan (cut-off value) bagi OKT-M, OHBS-M dan OSES-M dengan kesensitifan dan kespesifikan yang optimum untuk membezakan di antara pengetahuan, kepercayaan kesihatan dan kecekapan diri, yang tinggi dan rendah terhadap osteoporosis. Nilai-potongan OKT-M, OHBS-M dan OSES-M adalah 14, 169, dan 858, masing-masing. Kajian ini merumuskan bahawa OKT, OHBS and OSES adalah sah dan boleh dipercayai dan boleh digunakan dalam konteks pesakit diabetes di Malaysia.

Sampel seramai 450 orang pesakit T2DM dipilih daripada klinik pesakit luar diabetes di HPP untuk menilai status kesihatan tulang melalui pengukuran BMD (ketumpatan mineral tulang) menggunakan QUS, dan juga untuk menilai pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis. Berdasarkan QUS, prevalens BMD normal, osteopenia dan osteoporosis adalah 18%, 59.8% dan 22.2%, masing-masing.

Di samping itu, dapatan kajian menunjukkan bahawa 66.70%, 85.60% dan 71.30% daripada pesakit T2DM mempunyai tahap yang rendah bagi pengetahuan, kepercayaan kesihatan dan kecekapan diri, masing-masing. Tambahan pula, perkaitan yang signifikan ditemui di antara skor QUS-T, pengetahuan, kepercayaan kesihatan dan kecekapan diri terhadap osteoporosis. Keputusan menunjukkan bahawa skor QUS (BMD normal, osteopenia dan osteoporosis) secara subjektif

ditentukan melalui gabungan faktor kognitif dan tingkah laku, dan juga data sosiodemografi. Peramal bebas mempunyai perkaitan yang secara statistik adalah signifikan untuk membezakan kumpulan osteopenia dan osteoporosis daripada BMD normal adalah tempat tinggal, indeks jisim badan (BMI), gender, OKT-M, OSES-M dan sejarah keluarga berkenaan dengan patah/ fraktur. Selain itu, umur dan nilai HbA1c (kawalan glisemik) adalah ramalan hanya untuk osteoporosis. Hasil kajian ini adalah amat penting kerana ia dinyatakan faktor-faktor yang meramalkan keadaan osteoporosis dan membantu untuk memulakan tingkah laku pencegahan osteoporosis.

Dirumuskan bahawa skor QUS dapat dikaitkan dan terkesan oleh banyak faktor dalam kalangan pesakit T2DM. Justeru, penyedia penjagaan kesihatan sepatutnya memberi tumpuan yang khusus terhadap populasi berisiko tinggi apabila mempertimbangkan tentang pengurusan osteoporosis. Usaha gigih perlu diambil untuk meningkatkan pengetahuan, kepercayaan perubatan dan kecekapan diri terhadap osteoporosis bagi tingkah laku pencegahan osteoporosis yang berkesan. Dapatan kajian menunjukkan bahawa penilaian kesihatan tulang, pengetahuan, kepercayaan perubatan dan kecekapan diri pesakit terhadap osteoporosis adalah penting dan secara tidak langsung mencerminkan program pendidikan yang diperlukan pada masa depan untuk meningkatkan pengurusan osteoporosis.

**PREVALENCE OF OSTEOPENIA AND OSTEOPOROSIS: THE
ASSESSMENT OF OSTEOPOROSIS KNOWLEDGE, HEALTH BELIEF
AND SELF-EFFICACY AMONG PATIENTS WITH TYPE 2 DIABETES
MELLITUS IN PENANG**

ABSTRACT

Type 2 diabetes mellitus (T2DM) and osteoporosis are both chronic conditions and the relationship between them is complex. Knowledge, health belief and self-efficacy toward osteoporosis are fundamental to all osteoporosis management programs and are often a pre-requisite for initiating desired behavioural changes. Therefore, the aims of the present study were to assess the prevalence of osteoporotic conditions and the level of knowledge, health belief and self-efficacy toward osteoporosis among T2DM patients in Penang.

The most widely used instruments to assess knowledge, health belief and self-efficacy toward osteoporosis are the osteoporosis knowledge test (OKT), osteoporosis health belief scale (OHBS) and osteoporosis self-efficacy scale (OSES), respectively. Thus, a sample of 250 patients was conveniently recruited from the outpatient diabetes clinic at Hospital Pulau Pinang (HPP) for the purpose of validation of Malaysian versions of these three scales (OKT-M, OHBS-M and OSES-M). A standard “forward-backward” procedure was used to translate the scales into the Malay language. Reliability was tested for internal consistency and

validity was confirmed using face, content and construct validity. The results showed acceptable reliability and validity. In addition, the receiver operating characteristic (ROC) curve analysis was used to determine cut-off values for OKT-M, OHBS-M and OSES-M with the optimum sensitivity and specificity to distinguish between high and low osteoporosis knowledge, health belief and self-efficacy, respectively. The cut-off values of OKT-M, OHBS-M and OSES-M were 14, 169 and 858, respectively. This part of the study concluded that OKT, OHBS and OSES were valid and reliable and can be used among patients with diabetes in the Malaysian setting.

A convenient sample of 450 T2DM patients were recruited from the outpatient diabetes clinic at HPP to assess the bone health status by measuring the bone mineral density (BMD) using quantitative ultrasound scan (QUS), as well as to evaluate osteoporosis knowledge, health belief and self-efficacy. According to QUS, the prevalence of normal BMD, osteopenia and osteoporosis were 18%, 59.8% and 22.2%, respectively.

In addition, the study findings revealed that 66.70%, 85.60% and 71.30% of T2DM patients had a low level of osteoporosis knowledge, health belief and self-efficacy, respectively. Moreover, significant associations were found between the QUS T-scores, osteoporosis knowledge, health belief and self-efficacy. The results showed that QUS scores (normal BMD, osteopenia and osteoporosis) were subjectively determined by a combination of cognitive and behavioural factors, as well as socio-demographic data. The independent predictors that had a statistically significant relationship to distinguish the osteopenia and osteoporosis groups from normal BMD

were living place, body mass index (BMI), gender, OKT-M, OSES-M and family history of fracture. Moreover, age and HbA1c value (glycaemic control) were predictors only for osteoporosis. The results of this study were of great importance as it specified the factors that predict osteoporotic conditions and help to initiate osteoporosis preventive behaviours.

It is concluded that QUS scores were associated and affected by many factors in T2DM patients; therefore, healthcare providers should pay attention to those high risk populations when considering osteoporosis management. Extra effort is required to improve patients' knowledge, health belief and self-efficacy toward osteoporosis for effective osteoporosis prevention behaviour. The study findings revealed that the assessment of T2DM patients' bone health, knowledge, health belief and self-efficacy toward osteoporosis are crucial and highlight the required future educational programs to improve osteoporosis management.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

1.1.1 Osteoporosis

The major contributors to the increase in the rate of chronic disease are an aging population as well as a sedentary and unhealthy lifestyle (Bodenheimer *et al.*, 2009). The number of people with multiple chronic illnesses is expected to increase from 57 million in 2000 to 81 million by the year 2020 (Horton, 2009). In addition, more than three quarters of all health Medicare expenditure spending is for people with chronic conditions (Anderson and Horvath, 2004, Horton, 2009).

Osteoporosis is a chronic disease that represents a major serious public health concern due to its prevalence worldwide. Osteoporosis is the most common bone disease characterised by low bone mass, microarchitectural deterioration of bone tissue, compromised bone strength, and enhanced bone fragility, consequently predisposing an individual to an increased risk of fracture (Bouillon *et al.*, 1991, Kanis *et al.*, 1994). According to the World Health Organisation (WHO) diagnostic classification, osteoporosis is defined as a bone mineral density (BMD) value less than or equal to 2.5 standard deviations below the mean BMD of the young adult reference population (World Health Organization, 2003). Almost two-thirds of those who survive a fracture remain disabled and only 25% will resume normal activities (Jensen and Bagger, 1982, Cummings *et al.*, 1985, Clayer and Bauze, 1989).

Osteoporosis affects an enormous number of people worldwide. More than 200 million people have osteoporosis, regardless of race and gender, and its incidence will continue to rise as the population ages (Cooper, 1999). In the United States (U.S.), by the year 2002, it was estimated that more than 10 million individuals over the age of 50 will have osteoporosis and an additional 34 million individuals are at risk of having low bone mass and osteoporosis related-fractures (Cooper, 1999, National Osteoporosis Foundation, 2002, Holroyd *et al.*, 2008). By 2020, these numbers are estimated to rise to approximately 14 million individuals with osteoporosis and more than 47 million cases of low bone mass, as the population ages (U.S. Department of Health Human Services, 2004, Lane, 2006, National Osteoporosis Foundation, 2013).

Osteoporosis is primarily a woman's disease, especially postmenopausal women (Reginster and Burlet, 2006). In the U.S., eight million American women were estimated to have osteoporosis; women are usually more susceptible to osteoporosis as they lose approximately 20% of their bone mass in the first 5-7 years after menopause (U.S. Department of Health Human Services, 2004, Dempster, 2011). In the U.S. and the European Union, osteoporosis is found in 30% of all postmenopausal women, and it is expected that more than 40% of postmenopausal women will experience a fracture in later life (Melton *et al.*, 1992). Although osteoporosis is more prevalent in women, it can also affect men (Melton 2001). The incidence of osteoporosis also increases in men as they get older, with approximately 2 million American men affected with this disease (U.S. Department of Health Human Services, 2004).

With regard to ethnicity and osteoporosis risk, 20% of Caucasian, 20% of Asian, 10% of Hispanic and 5% of African-American women over the age of 50 years have osteoporosis. Moreover, 52%, 52%, 49% and 35% of these women, respectively, have low bone mass and are at risk of developing osteoporosis (National Osteoporosis Foundation, 2013). However, Caucasian and Asian women still bear the immense global burden of osteoporosis (U.S. Department of Health Human Services, 2004).

Osteoporosis is considered as a silent disease (as it occurs without symptoms) and is usually undetected until fracture occurs. All fractures are associated with considerable morbidity, lower quality of life, long-term disability (including pain, height loss and inability to stand and walk), as well as increased mortality (Barrett-Connor, 1995, Salkeld *et al.*, 2000, National Institutes of Health, 2001, Colon and Saag, 2006). Thus, fractures are the biggest and the most devastating complication facing most individuals with osteoporosis (Leibson *et al.*, 2002, Dempster, 2011). Worldwide, it is estimated that there were about 1.7 million osteoporosis-related fractures in 1990 and this figure is expected to rise to 2.6 million by the year 2025 (Gullberg *et al.*, 1997, Johnell and Kanis, 2004, U.S. Department of Health Human Services, 2004). Moreover, osteoporosis-related fractures account for 0.83% of non-communicable disease in terms of global burden. The greatest proportion of osteoporosis-related fractures are found in Europe (36.6%), whereas Southeast Asia (15.5%) and North and South America (16.0%) have a lower prevalence (Johnell and Kanis, 2006).

In the U.S., the estimated costs of the potential consequences of osteoporosis and osteoporosis-related fractures were between \$13.7 and \$20 billion in 2005; this figure is expected to rise to more than \$25 billion by 2025 with over 3 million fractures as the population ages (Burge *et al.*, 2007, Watts *et al.*, 2010). Moreover, one year after fracture surgery, individuals' annual medical costs are estimated to be \$14,600 (Gabriel *et al.*, 2002). In the United Kingdom (UK), the medical costs of osteoporosis and fractures are expected to be approximately £615 million annually (Kanis and Pitt, 1992).

Although the risk of developing osteoporosis is highest in North America and Europe, it is expected to rise more in Asian countries as the population ages (Genant *et al.*, 1999). The Asian Osteoporosis Study (AOS), which was the first extensive study conducted in Asia, showed that the incidence of hip fracture in Hong Kong and Singapore was similar to an American Caucasian population (Lau *et al.*, 2001b). A recent Asian study showed an increase in mortality risk of hip fracture that persisted for 5 years after fracture in both men and women (Koh *et al.*, 2013). In Asia, according to the WHO, it was expected that the number of people aged over 65 years will be approximately 900 million by the year 2050. Consequently, the figures for hip fracture in Asian countries is expected to rise from 30% in 1990 to more than 50% by the year 2050, with approximately 3.2 million people affected annually (Cooper *et al.*, 1992, Gullberg *et al.*, 1997, Lau, 2002).

1.1.2 Diabetes mellitus

In recent decades, the ability to diagnose and treat diabetes mellitus by medical professionals has greatly grown with an increase in medical knowledge and new

technologies. However, the effectiveness of this growth is challenged by the requirement for patients to change their behaviour. Diabetes mellitus (DM), along with other chronic diseases such as cardiovascular diseases (CVD), cancer and mental illnesses, now accounts for approximately 47% of the global health burden of disease and more than half of all deaths (Darnton-Hill *et al.*, 2004, Wild *et al.*, 2004).

Diabetes is mounting health problem in the contemporary era and its prevalence is increasing continuously with a high degree of co-morbidity and mortality (Beckley, 2006, Hu, 2011). According to the International Diabetes Federation (IDF), approximately 366 million people are diabetic and this number is expected to rise to approximately 552 million by the year 2030 (Whiting *et al.*, 2011). Moreover, there is an increasing in the number of people with impaired glucose tolerance from 344 million in 2010 to 472 million expected by the year 2030 (Hu, 2011). Moreover, it was determined that diabetes mellitus accounted for 12% of worldwide total healthcare expenditures, or approximately \$376 billion in 2010, and this figure is expected to reach \$490 billion by the year 2030 (Zhang *et al.*, 2010). Type 2 diabetes mellitus (T2DM) accounts for about 90% of the cases of diabetes and is more likely to occur in developing countries due to a sedentary lifestyle, aging, obesity and poor dietary habits (Darnton-Hill *et al.*, 2004). In addition, most people with diabetes cases live in low- and middle-income countries (Hu, 2011).

Diabetes can affect any person of either gender, at any age from any race or socio-economic background; however, Asian are affected more than Caucasians (Hu, 2011). In Asia, diabetes accounts for more than 60% of the diabetic population worldwide as a consequence of rapid economic growth, urbanisation and nutritional

transitions status (Chan *et al.*, 2009). Asians develop diabetes at lower degrees of obesity and at younger ages, which means that they suffer longer from complications and die sooner than people from other regions (Ko *et al.*, 1999, Yoon *et al.*, 2006, Chan *et al.*, 2009). Thus, the prevalence of diabetes in this racially heterogeneous population with different demographic, cultural and socio-economic backgrounds has rapidly increased among urban and younger people (Wild *et al.*, 2004, Yoon *et al.*, 2006, Ramachandran *et al.*, 2010, Shaw *et al.*, 2010).

Countries undergoing substantial socio-economic growth and urbanisation are more likely to show an increase in the prevalence of diabetes, and data from an epidemiological study in Asia has attracted considerable attention to this problem (Ramachandran *et al.*, 2010). Urban lifestyles are associated with a lower level of physical activity and increased diversity in the diet with more unsaturated and total fats and a lower intake of fibre. Chronic diseases like diabetes are diet-related, and the effect of poor dietary habits is significant to the aetiology of these diseases (Chan *et al.*, 2009). This may lead to a rapid increase in diabetes prevalence within a relatively short time. For example, in China, the prevalence of diabetes is expected to rise from less than 1% in 1980 to 10% by the 2008, with more than 92 million diabetes patients and 148 million people in a prediabetic status (Yang *et al.*, 2010b). These results suggest that China has overtaken India and become the global diabetes epidemic epicentre. However, in urban areas in the south of India, the prevalence of diabetes has reached nearly 20% (Ramachandran *et al.*, 2008).

1.2 Osteoporosis and diabetes mellitus in Malaysia

1.2.1 Osteoporosis in Malaysia

Osteoporosis is considered to be one of the most prevalent and costly diseases across Asia, as the population is rapidly increasing and aging (Yeap *et al.*, 2013). The prevalence of osteoporosis increases markedly after the age of 50 in postmenopausal women in Asia (Kim *et al.*, 2000, Lin *et al.*, 2001, Jang *et al.*, 2006). In Malaysia, the prevalence of osteoporosis in postmenopausal women was reported as 24.10% in 2005, although the prevalence of osteoporosis was much lower in Thailand (12.60%), China (16.10%) and Taiwan (10.08%) (Lin *et al.*, 2001, Jang *et al.*, 2006, Loh and Shong, 2007). Overall, Asian countries have a higher prevalence of osteoporosis than western countries, which may be attributed to the fact that the Asian population has a lower body mass index, weight and shorter height (Babbar *et al.*, 2006).

In view of the country's rapidly ageing population, the prevalence of osteoporosis is estimated to rise. In Malaysia, it is expected that the number of people over the age of 60 will increase from 1.4 in 1999 to approximately 3.3 million by 2020 (Mafauzy, 2000, Noor, 2002). Due to rapid urbanisation and economic growth in Malaysia over the last three decades, there has been a shift in the diet and lifestyle with an increase in the prevalence of chronic diseases (Tee, 1999). Thus, osteoporosis may be projected to burden the healthcare system if appropriate intervention and management is not undertaken.

Moreover, epidemiological studies have estimated an exponential rise in the incidence of osteoporosis and fractures in Asia. According to the WHO, by the year 2050, it is estimated that one out of every two people that experience a fracture in the world will live in Asia (Cooper *et al.*, 1992). In Malaysia, it is estimated that the incidence of hip fractures among individuals over the age of 50 was 90 per 100,000 and 500 per 100,000 in people over the age of 75, with direct costs from hospitalisation reaching 22 million Ringgit (approximately \$ 6 million) in the year 1997 (Lee and Khir, 2007). With regards to race and the specific incidence of hip fractures in Malaysia, the results show that the incidence is higher among the Chinese (160 per 100,000) than Indians (150 per 100,000) and Malays (30 per 100,000) (Lee and Khir, 2007). Moreover, it is expected that the number of hip fractures in women will double as women are more likely to be affected than men, with 218 and 88 cases per 100,000 people, respectively (Lau *et al.*, 2001a). No Malaysian data are available on the incidence of other fractures due to osteoporosis.

According to the Asian Osteoporosis Study, the rate of hip fractures in Malaysia is lower than other in Asian countries (Lau *et al.*, 2001a). However, with urbanisation and ageing, this rate is more likely to escalate (Ross, 1996). Moreover, the total economic burden of osteoporosis and fractures in Asia has been underestimated, as most studies did not account for the costs of rehabilitation and long-term nursing care (Mithal *et al.*, 2009a). The best way to control osteoporosis is through aggressive prevention strategies targeting high-risk individuals, according to the latest Malaysian Clinical Guidance (Yeap *et al.*, 2013). As such, screening and monitoring osteoporosis can be important prevention strategies (Summers and Brock, 2005).

1.2.2 Diabetes mellitus in Malaysia

Malaysia is a multi-ethnic country with a total population of 29 million (Department of Statistics Malaysia, 2010). In Malaysia, according to the Third National Health and Morbidity Survey (NHMS-3), it was estimated that the prevalence of T2DM in individuals aged 30 years and over has increased from 8.30% in 1996 to 14.90% by the year 2006, with the greatest increase in the Indian population (Zanariah *et al.*, 2008, Letchuman *et al.*, 2010). Moreover, it is expected that the number of individuals with diabetes will rise from 1,846,000 in 2010 to 3,254,994 in 2030, and the adjusted diabetes incidence (adjusted to the world population) in Malaysia will increase from 11.6% in 2010 to 13.8% by the year 2030 (International Diabetes Federation, 2009). According to the Malaysian Ministry of Health, there has been an increase in the prevalence of chronic diseases, including diabetes, within Malaysian population (Ministry of Health Malaysia, 2009).

This increase in the prevalence of diabetes is associated with many factors, including the rapid economic growth of the country in the last few decades, urbanisation and industrialisation, which have resulted in more overweight/obese people and a sedentary life style (Ismail *et al.*, 2002, Mustaffa, 2004, Yun *et al.*, 2007, Kee *et al.*, 2008, Rashid, 2008). In Malaysia, it is estimated that the number of individuals aged 65 years and over was gradually increased from 4.3% in 2005 to 4.8% in 2007, which was much higher than the increase in younger individuals (Yahya *et al.*, 2008). In this age group, around 25% to 30% of individuals have diabetes or glucose intolerance (Wild *et al.*, 2004).

Diabetes mellitus can be controlled and managed, but it cannot be cured completely, with a combination of medical care, patient education and self-management (Ali and Jusoff, 2009, Funnell *et al.*, 2009, Ministry of Health Malaysia, 2009, Shrivastava *et al.*, 2013). Multiple diabetes complications in Malaysian T2DM patients have been found, with an incidence as high as 38% to 50% (Dhanjal *et al.*, 2001, Mimi *et al.*, 2003, Ooyub *et al.*, 2004, Mafauzy, 2006a). Out of all the patients who require dialysis in Malaysia, 57% are patients with diabetic nephropathy (Lim and Lim, 2006), and 55% of patients who suffered from stroke also had diabetes (Wong, 1999, Hamidon and Raymond, 2003). Diabetes mellitus was eighth in the list of top ten causes of death by non-communicable disease in Malaysia (Yusoff *et al.*, 2013). Many Malaysian studies that focused on diabetes showed a large proportion of patients with poor or suboptimal glycaemic control and a mean HbA1C higher than the value recommended by guidelines (Ismail *et al.*, 2000, Chuang *et al.*, 2002, Wong and Rahimah, 2004, Tan and Magarey, 2008, Kamarul Imran *et al.*, 2010).

1.3 Osteoporosis care and prevention

Osteoporosis is a major health problem in Asia. Osteoporosis may arise at any time and some of the most important risk factors that may lead to develop osteoporosis include genetics, lifestyle, nutrition, inadequate calcium intake and physical activity, vitamin D deficiency and decreased production of sex hormones (U.S. Department of Health Human Services, 2004, Yeap *et al.*, 2013). Osteoporosis causes serious medical complications, not only restricted to the immediate pain resulting from fractures, but may also cause a wide range of serious medical consequences and affect total quality of life, as shown by many Malaysian studies (Lai *et al.*, 2008, Lai *et al.*, 2013). For instance, the surgical procedure for a hip fracture may lead to

morbidity and may even cause death due to serious medical complications (Hannan *et al.*, 2001). It is estimated that up to 20% of mortality risk is associated with post hip fracture complications. In addition, 40% of patients suffer sustained disability and a loss of independence, which require long-term nursing care. Therefore, osteoporosis-related fractures are considered a major public health problem and challenge in Asia (Lau *et al.*, 2001a, Kung *et al.*, 2013). The problem is further exacerbated as the overall nutrition and economic situation in these regions have shifted over the last few decades, which has led to an excessive increase in health care costs and socioeconomic impact due to osteoporotic fractures in Asia (Gullberg *et al.*, 1997).

Adaptation of an unhealthy lifestyle such as inadequate regular physical activity and low dietary calcium intake have been found to be major risk factors for osteoporotic fractures in Asia (Lau *et al.*, 2001b). Moreover, many epidemiological studies have identified a high incidence of vitamin D inadequacy and as a results an increased incidence of osteoporosis in Asian populations (Mithal *et al.*, 2009b, Chan *et al.*, 2010, Ho-Pham *et al.*, 2011). Similar results have been found in Malaysian postmenopausal women (Rahman *et al.*, 2004). Prevention of osteoporosis should begin at birth and continues throughout the lifespan. Thus, to slow down bone loss, corrective action must be undertaken by the adaption of a healthy lifestyle including regular exercise and adequate dietary calcium intake (Chee *et al.*, 2003, Ting *et al.*, 2007, Yeap *et al.*, 2013). However, the lack of bone disease awareness in the public is one of the biggest problems in term of the prevention of osteoporosis. Moreover, there is a common misunderstanding that osteoporosis is a disease only in women and in the aged population (Mudano *et al.*, 2003, Qaseem *et al.*, 2008). As a

consequence, such an incorrect view may delay the prevention and management of osteoporosis.

The prevention of osteoporosis consists of three types: primary, secondary and tertiary prevention. Primary prevention involves general management that includes the assessment of the risk of falls and their prevention to avert the onset of disease (Chang *et al.*, 2004). It includes encouraging adequate calcium and vitamin D intake and exercise (Body *et al.*, 2011, Yeap *et al.*, 2013). Secondary prevention involves early diagnosis and prompt treatment, including fall prevention and using anabolic agents. Tertiary prevention includes comprehensive treatment of fractures and, at this level, professional healthcare efforts to retrain and rehabilitate the individual with impairments and/or disability (National Institutes of Health, 2001, U.S. Department of Health Human Services, 2004, Yeap *et al.*, 2013).

1.4 Osteoporosis knowledge, health belief and self-efficacy

1.4.1 Osteoporosis knowledge

Information pertaining to the awareness and the level of knowledge regarding bone health status and its risk factors are still very limited among adults in Asian (Nguyen and O'Connell, 2002) and in Malaysian community-based studies (Jamila *et al.*, 2010, Yeap *et al.*, 2010). The major obstacles that been identified in the management of osteoporosis included a limited level of awareness and knowledge within the population, as well as low priority to initiate an appropriate preventive and curative plan by healthcare professionals (Cinda and Sava 2004, Chang *et al.*, 2007, Giangregorio *et al.*, 2007, Yeap *et al.*, 2010). Generally, in the chronic disease

management area, increased awareness and knowledge about a disease is associated with improved patient compliance and adherence by increasing the identification of problem and awareness about the decision process (Kennedy and Rogers, 2002).

Several community-based studies have identified a low level of osteoporosis knowledge in other countries (Sedlak *et al.*, 2000a, Yu and Huang, 2003, Chang, 2004, Ailinger *et al.*, 2005, Jalili *et al.*, 2007, Chang, 2008, Aree-Ue and Petlamul, 2013). Although a good understanding of the disease condition may not be adequate to make significant changes in health-related behaviour, knowledge is still a prerequisite step for success in adopting and continuing a healthy lifestyle for preventive efforts (Gurney and Simmonds, 2007, Ozturk and Sendir, 2011). Thus, screening and prevention strategies are cornerstones of appropriate osteoporosis management, and education plays a key role in improving osteoporosis outcomes (Yeap *et al.*, 2013).

Due to the number of challenges faced by healthcare professionals to implement guidance, including a lack of osteoporosis awareness, knowledge, understanding responsibilities regarding management and restricted access to diagnostic equipment (Levine, 2011), knowledge of osteoporosis is a central part of informed decision making on the pharmacological and non-pharmacological aspects of osteoporosis management (Body *et al.*, 2011). Therefore, improved information on osteoporosis and associated fractures for the high risk populations are important osteoporosis preventive strategies. Moreover, many previous studies have shown that a well-developed educational program is essential for the improvement of osteoporosis prevention behaviour and fracture-related outcomes in terms of improving bone

health. Thus, an evaluation of the educational needs of patients is an essential first step (Piaseu *et al.*, 2001, Aree-Ue *et al.*, 2006).

1.4.2 Osteoporosis health beliefs

The osteoporosis health beliefs play central roles in osteoporosis prevention and behaviour management. Based on health belief model (HBM) theory, health behaviour is determined by personal beliefs or perceptions toward the disease and its preventive strategies (Janz and Becker, 1984). HBM is the most widely used theory in health promotion and educational programmes (Turner *et al.*, 2004). Therefore, HBM theory is used in osteoporosis research and practice (Wallace, 2002, Edmonds *et al.*, 2012). HBM theory proposes that individual prevention behaviours toward osteoporosis increase, if patients feel susceptible, believe that the occurrence of osteoporosis would have a severe impact on their lives and conclude that preventive measures are beneficial, outweighing any barriers involved in taking action (Rosenstock, 1974, Cadarette *et al.*, 2004, Hazavehei *et al.*, 2007, Painter *et al.*, 2008).

By utilising HBM theory, researchers can investigate and understanding the health behaviours and the reasons for non-compliance to osteoporosis prevention programs (Turner *et al.*, 2004). Thus, HBM has been used to explain change and provides a guiding framework for health behaviour interventions (Glanz *et al.*, 2008). Many osteoporosis research studies utilise this model to plan and intervene in populations at risk of having osteoporosis in an attempt to determine which variables lead some individuals to engage in healthy behaviours and which variables hinder a person's performance (Sedlak *et al.*, 2000a, Chan *et al.*, 2007). In Asia, many studies have

shown that most individuals have low osteoporosis health beliefs and they do not engage or practice in preventative measures for osteoporosis, which places them at a higher risk of low bone mass accruals, even though they are aware that they are vulnerable to the risk of osteoporotic fractures in later life (Nguyen and O'Connell, 2002, Lee and Lai, 2006, Aree-Ue and Petlamul, 2013, Kim *et al.*, 2013). A better understanding of the interactions of all these aspects of knowledge, beliefs, dietary and lifestyle practices in relation to positive bone health status and osteoporosis prevention among individuals will ultimately help them to make a better decisions on how to maximise their bone mass during earlier stages of life in order to prevent the risk of osteoporosis in later life.

1.4.3 Osteoporosis self-efficacy

Self-efficacy is refers to an individual's confidence about their ability to perform a particular behaviour successfully (Bandura, 1977, Bandura, 2004). Therefore, self-efficacy determines how people think, feel, motivate and behave toward disease. Individuals with greater self-efficacy are more likely to motivate and engage in healthy behaviours and maintain these behaviours for more positive outcomes and less negative outcomes (Luszczynska *et al.*, 2005). The self-efficacy building process includes an interaction between emotional states, motivation and outcome expectancy (Bandura and Adams, 1977). Self-efficacy contributes to motivation by helping people to determine their goals, how much effort they expend, how long they persevere in the face of difficulty and their resilience to failures.

Osteoporosis educational intervention programmes is crucial to enhancing knowledge and prevention behaviour regarding osteoporosis; as well, it creates the

precondition for health behaviour changes (Piaseu *et al.*, 2001). In general, the individuals is more likely motivated to act when they realise that changing their behaviour is beneficial to reducing the risk of osteoporosis. This motivation is very important in self-efficacy theory (Laslett *et al.*, 2004). Many osteoporosis studies have shown that self-efficacy is considered one of the best predictors of health behaviours, particularly in terms of increasing physical activity and dietary calcium intake (Wallace and Ballard, 2002, Jones *et al.*, 2005, Hsieh *et al.*, 2008). Moreover, many community-based studies have shown low self-efficacy toward osteoporosis (Piaseu *et al.*, 2001, Brecher *et al.*, 2002, Doheny *et al.*, 2010, Ozturk and Sendir, 2011, Khorsandi *et al.*, 2012, Aree-Ue and Petlamul, 2013). Therefore, increasing self-efficacy perceptions toward osteoporosis are of significant importance in osteoporosis preventive behaviours (Sedlak *et al.*, 2000a).

1.5 Research Problems

Diabetes and osteoporosis management is a lifelong process that requires effort from healthcare providers and patients. However, the patient is the key to successful management, and serious complications can result from poor management. Patients must be proficient to successfully manage, maintain lifestyle changes and make daily decisions for better health, while the healthcare professional has the responsibility to help patients to make the right decisions and cope with the difficulties and barriers through education, support and advice (Funnell and Anderson, 2004, Levine, 2011).

This study has illustrated the following problems:

1. The proportion of low bone mineral density is high among the general population in Asia. As well, the prevalence of osteoporosis in

postmenopausal women in Malaysia is also high. In Malaysia, there has been a shortage of data on the topic of the prevalence of osteoporotic conditions among T2DM patients.

2. To date, there have been few academic and empirical published papers regarding osteoporosis knowledge, health belief and self-efficacy, and most of the reviews on this subject have been conducted in western countries. In Malaysia, there has been a lack of data on the topic of patient knowledge, health beliefs and self-efficacy regarding osteoporosis among T2DM patients.
3. No validated Malaysian tools have been found for the assessment of osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients.
4. Scarce results have been published regarding the association of bone mineral density measurement and osteoporosis knowledge, health beliefs and self-efficacy in patients with T2DM.

1.6 Rationale of the study

Osteoporosis is a growing health problem in Malaysia with a high cost in terms of economics and disability. In Malaysia, it is estimated that 27,000 people break a hip every year because of osteoporosis. The hip fracture incidence among individuals aged 50 years and over was 90 per 100,000 with 22 million Ringgit direct hospitalisation costs in the year 1997. In addition, it is estimated that the number of hip fractures in females is double compared to males (Lau *et al.*, 2001a, Lee and Khir, 2007). The prevalence of osteoporosis in Malaysia was 24.10% in 2005, which is considerably higher than other Asian countries (Loh and Shong, 2007). This may

be due to rapid socio-economic growth, enormous urbanisation and changes in dietary habits.

In all countries studies reviewed, there is evidence of underdiagnosed and underestimated osteoporosis among the general population (Vestergaard *et al.*, 2005, Haussler *et al.*, 2007) and among diabetic patients (Abdulameer *et al.*, 2012c, Luft, 2012). Many studies have shown that T2DM is related to various skeletal disorders, including osteoporosis and osteopenia (Thraillkill *et al.*, 2005, Abdulameer *et al.*, 2012c, Hamann *et al.*, 2012). Moreover, it has long been known that alterations in bone and mineral metabolism are clinically complicated in patients with diabetes mellitus (Levin *et al.*, 1976, Ishida *et al.*, 1985, Piepkorn *et al.*, 1997). Many studies findings have shown a loss of bone mass that consequently leads to decreased BMD and osteoporosis among T2DM patients with poor glycaemic control (Krakauer *et al.*, 1995, Linda *et al.*, 2003, Majima *et al.*, 2005). Several mechanisms have been proposed for diabetes-related osteoporosis. These include both the co-morbidities of diabetes and the more direct pathophysiological effects of the disease itself (Lenchik *et al.*, 2003, Inzerillo and Epstein, 2004).

Furthermore, patients with T2DM frequently do not adhere to their prescribed medications and, consequently, poor glycaemic control can result, with an increased incidence of diabetic complications, increased morbidity and mortality and increased health care facilities utilisation (Delamater, 2006, Fowler, 2008, Ahmad *et al.*, 2013). Thus, encouraging diabetes self-management and improved glycaemic control play a key role in decreasing and protecting bone mass loss in T2DM patients (Gregorio *et*

al., 1994, AL-Elq and Sadat, 2006, Xu *et al.*, 2007, Al-Zaabi *et al.*, 2008, Tao *et al.*, 2008).

Although numerous measures have been taken to improve bone health and osteoporosis management through published Malaysia guideline (Yeap *et al.*, 2013), there is a lack of good bone health control and osteoporosis management. In Malaysia, it is important to explore patient knowledge, health beliefs and self-efficacy toward osteoporosis and their awareness by identifying the source of information. It is also imperative to understand the contribution of osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients regarding bone mineral density measurements to promote better osteoporosis prevention behaviour.

Lack of awareness and proper osteoporosis management are responsible for the high prevalence of low bone mass (Patel *et al.*, 2004, Winzenberg *et al.*, 2005, Doheny *et al.*, 2007, Spencer, 2007). Thus, it has been recommended that osteoporosis education should be a component of the diabetes management process by the health system as diabetes is a risk factor for developing osteoporosis (Brown and Sharpless, 2004). Most of the interventions that attempt to improve osteoporosis knowledge, health beliefs and self-efficacy in community-based studies were educational programs; therefore, for a proper intervention that leads to changes in patient behaviour, it is important to first evaluate osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients. Osteoporosis prevention behaviour and education must be adjusted to the level of knowledge of the patients and should be culturally sensitive.

1.7 Significance of the study

As a result of the rapidly growing prevalence of diabetes and osteoporosis with the evidence that normal bone mineral density (healthy bone) among T2DM patients is associated with reduced morbidity, mortality and disability, osteoporosis prevention behaviours have been considered an important part of the management of patients with T2DM (Janghorbani *et al.*, 2007, Luisa Isidro and Ruano, 2010, Luft, 2012). Currently, osteoporosis is considered a problem in women as well as in men, and particularly in elderly persons.

Many educational interventions program for osteoporosis prevention have been offered to and evaluated in community level studies. However, osteoporosis in the clinical setting is still underdiagnosed, undertreated, under-reported and inadequately researched. Even among the Malaysian population with a high risk of osteoporosis, the population reported significantly fewer osteoporosis diagnoses than other Asian populations (Kung *et al.*, 2013). In Malaysia, elderly patients with osteoporosis-related fractures are at greater risk for increased disability, high annual costs of healthcare, loss of productivity and quality of life; this is a major issue that has to be dealt with (Lau *et al.*, 2001a, Seng-Kim, 2009, Yusoff *et al.*, 2013). Therefore, screening people with high risk factors of developing osteoporosis like T2DM is considered crucial for preventing osteoporosis progression and related fractures.

If no comprehensive prevention strategies are implemented, the prevalence of osteoporosis and fractures is estimated to increase by double or triple by 2040 (Morris *et al.*, 2004, Burge *et al.*, 2007). Many studies have reported that osteoporosis-related fractures tend to result in significant morbidity, mortality and

financial expense (Caliri *et al.*, 2007, Qaseem *et al.*, 2008, Becker *et al.*, 2010). Lifestyle behaviours that influence the development of healthy bones included adequate exercise, weight control, balanced nutrition, and adequate calcium and vitamin D intake (Elgan *et al.*, 2005, Morgan, 2008, Gracia-Marco *et al.*, 2011, Yeap *et al.*, 2013). Health beliefs often influence these lifestyle choices (Sadler and Huff, 2007). Primary prevention strategies need to be increased and targeted toward groups at high risk of developing osteoporosis. Although osteoporosis is considered an inevitable disease, it is still vitally important to take effective action to deal with this disease, such as a balanced diet containing calcium-rich food and engaging in regular physical activity (Levine, 2006, Tung and Lee, 2006). Assessing osteoporosis knowledge and the extent to which preventive health behaviours are practiced among T2DM patients will give a better comprehensive evaluation of osteoporosis management.

However, little is known regarding specific osteoporosis awareness, knowledge, health beliefs and self-confidence needed for T2DM patients to effectively participate in prevention behaviours. Therefore, the assessment of these is important for improving T2DM patient outcomes. This study will attempt to discover the association between osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients and bone health status. Moreover, there is a lack of research concerning osteoporosis knowledge, health beliefs and self-efficacy among T2DM patients of both genders and multiple races. This may stem from the majority of research being conducted in these areas among healthy individuals or postmenopausal elderly women.

At the end of this study, healthcare professionals and authorities will have a clearer picture of the problems related to osteoporosis in T2DM patients. This study will explore patient perceptions of osteoporosis, identify patients with poor osteoporosis knowledge, health beliefs and self-efficacy, as well as identify patients with low bone mass. The results will help in future planning of educational programs for patients with diabetes and help health care providers to concentrate on those patients with high risk factors for developing osteoporosis or low bone mass.

1.8 Research objectives and questions

1.8.1 Objective of the study

Osteoporosis among T2DM patients is a major public health problem that requires urgent attention. Patients often do not consider the diabetic condition to be a risk factor affecting bone health. Thus, it is important to understand the contribution of knowledge, health beliefs and self-efficacy in order to provide better care and prevention. To date, scarce data have been published in terms of the assessment of osteoporosis knowledge, health beliefs and self-efficacy, as well as its prevalence in T2DM patients. Therefore, further exploration of the association between osteoporosis knowledge, health beliefs and self-efficacy and the effect of these factors on bone mineral density measurement is needed. The principal purpose of the study was to investigate the prevalence of low bone mass and to assess osteoporosis knowledge, health beliefs and self-efficacy and the association of these factors on bone health. The study findings may provide the healthcare system with a better understanding of the risk of diabetic disease on bone health status, as well as the

effect of osteoporosis knowledge, health beliefs and self-efficacy on bone mineral density measurements in patients.

The specific aims of this study are:

1. To determine the prevalence of low bone mineral density (LBMD, i.e., osteopenia and osteoporosis) in T2DM patients using quantitative ultrasound method (QUS).
2. To assess the difference in QUS parameters of the calcaneus stratified by age and gender.
3. To evaluate the correlation between QUS parameters and T-score values with patient demographic characteristics, diabetes-related data, and lipid and blood pressure profiles.
4. To evaluate the association between QUS-score (normal BMD, osteopenia and osteoporosis) and demographic characteristics, diabetes-related data, lipid and blood pressure profiles.
5. To translate, validate and assess the psychometric properties of the chosen tools for the assessment of osteoporosis knowledge, health beliefs and self-efficacy.
6. To assess the level of osteoporosis knowledge, health beliefs and self-efficacy among patients with type 2 diabetes.
7. To assess the correlation and differences of demographic characteristics, diabetes-related variables as well as lipid and blood pressure profiles with osteoporosis knowledge, health beliefs and self-efficacy.
8. To assess the correlation between osteoporosis knowledge, health beliefs and self-efficacy scales and subscales.

9. To assess the correlation between T-score values using QUS and osteoporosis knowledge, health beliefs and self-efficacy.
10. To assess the potential factors that predicts the QUS measurement score in T2DM patients.

1.8.2 Research questions

The study addressed the following questions:

1. Is there a high prevalence of low bone mineral density? What is the percentage of osteopenia and osteoporosis in T2DM patients?
2. Is there a deficiency in osteoporosis knowledge, health beliefs and self-efficacy among patients with T2DM?
3. Which of the three variables (osteoporosis knowledge, health beliefs and self-efficacy), including interactions between variables, account for the most variance in predicting bone mineral density measurements?
4. What is the type and strength of the relationship between patient characteristics and osteoporosis knowledge, health beliefs and self-efficacy, as well as the outcome (normal bone mineral density)?

1.9 Thesis overview

In this thesis, chapter 2 reviews the literature related to the study with the definition of terms and provides a conceptual framework. A thorough review of literature relevant to the study, focusing on the possible relationship between osteoporosis and diabetes elsewhere in the world form the bulk of this chapter. The chapter continues with an overview of the beneficial use of osteoporosis knowledge, health beliefs and self-efficacy in research studies.